# How Energy Crops Affect Soil Hydrology: Recharge, Residence Times and Resilience

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**Research Areas Lignocellulose / Biogas – Interconnected Project**

## Introduction

Increase of bioenergy will result in changes in land use and may generate new chances and risks. We developed a new, rapid measurement approach to investigate the influence of energy plants on the water cycle. The environmental assessment is focusing on water use and water quality, percolation, risk of erosion and nutrient export from the different energy plants. A database for Baden-Württemberg (BW) to be used by the energy sector and for water management for a targeted use of energy plants is in development. It can be used to propose new land use planning to find the optimum between water protection and bioenergy use.

## Methods and approach

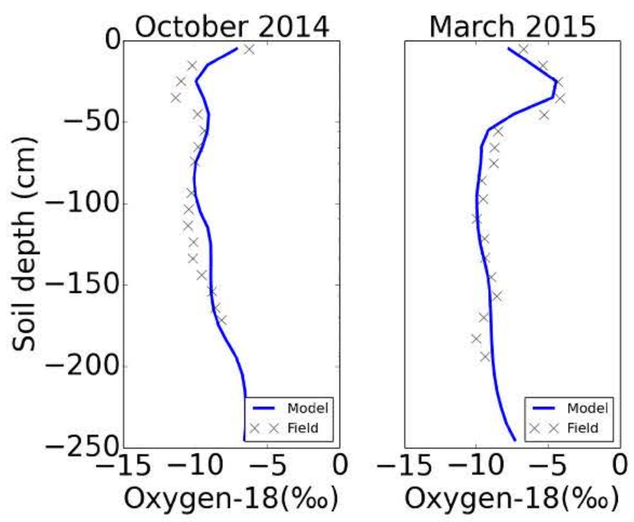
**Field Campaign**
- 11 Sites and 89 Plots in BW
- 70 Energy Plant Plots
- 11 Infiltration Experiments

**Lab Analytics**
- 1150 Soil Samples
- N-$NO_3$
- Stable Isotopes: $^{18}O$, $^{2}H$

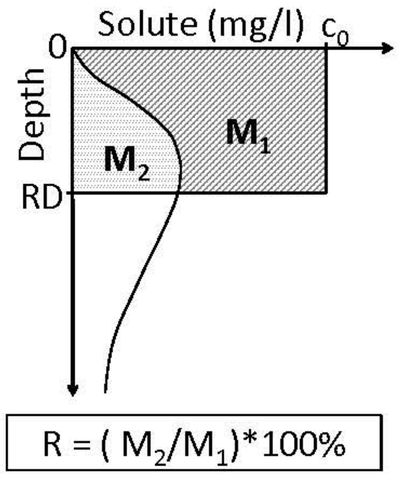
**Models**
- Data Regionalization
- Soil Model Development
- Soil Model Validation
- Prediction

**Results**
- Deep Percolation
- Transit Times
- Nitrate Resilience
- Water + Mass Balances

*Soil core*

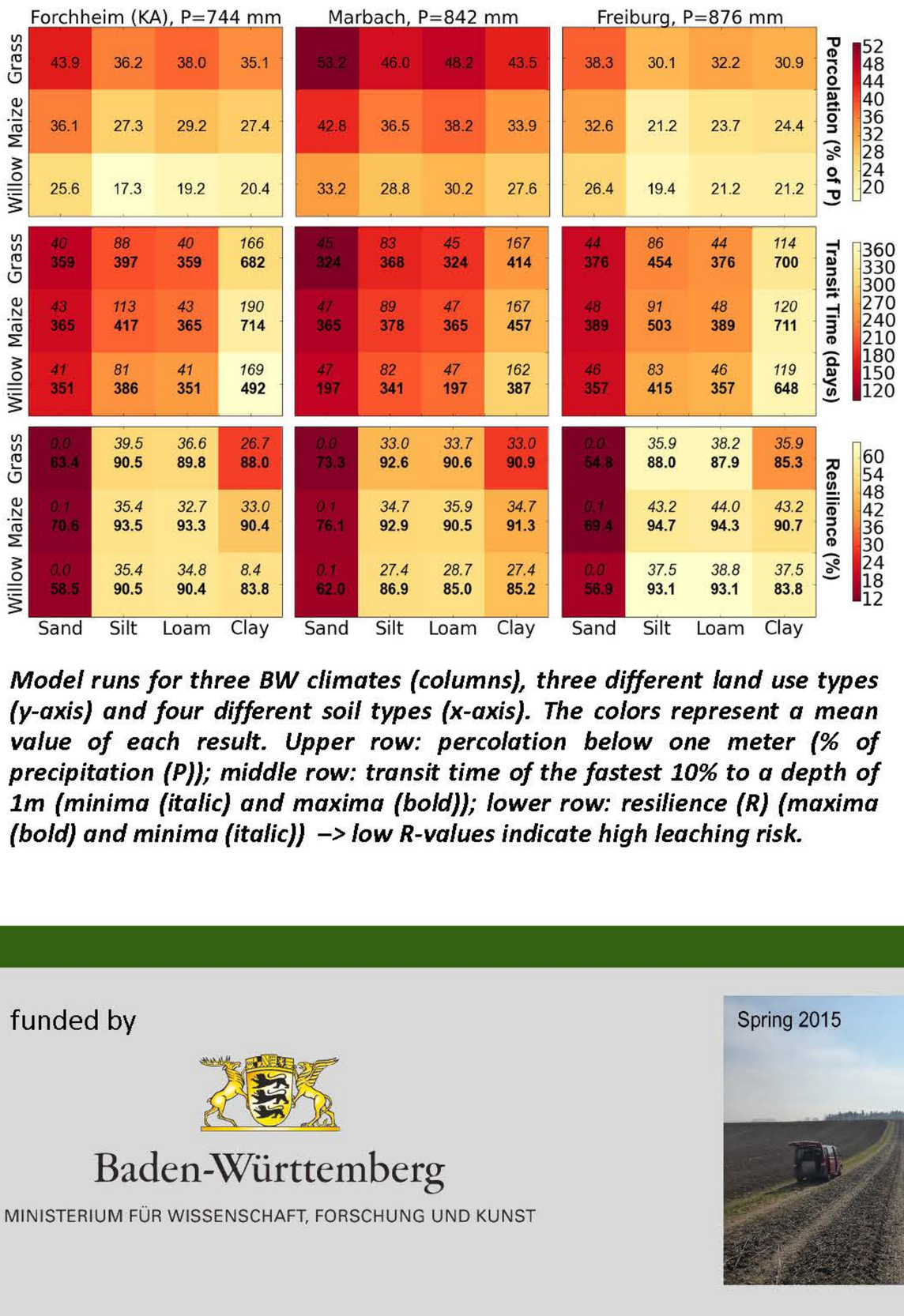



***Example for model validation: field data and modelled data after and before vegetation period of one location near Karlsruhe, land use: willow.***




***Nitrate Resilience (R): percentage of nitrate (or other substance) solved in soil water that remains in the rooting zone (RD) after the non-vegetation period (31.10.-31.03.)***

## Results




***Model runs for three BW climates (columns), three different land use types (y-axis) and four different soil types (x-axis). The colors represent a mean value of each result. Upper row: percolation below one meter (% of precipitation (P)); middle row: transit time of the fastest 10% to a depth of 1m (minima (italic) and maxima (bold)); lower row: resilience (R) (maxima (bold) and minima (italic)) –> low R-values indicate high leaching risk.***

→ **Model** validation is reliable, simulated isotope profiles are in good agreement with observations in the field.

→ Multiple years of **water** and **mass balances**.

→ **Percolation** is strongly influenced by land use and climate.

→ **Transit Time** is influenced by a combination of soil type, climate and land use, but the effect of soil type is very strong.

→ **Resilience** defined for the non vegetation period is strongly influenced by soil type.

→ **High variability** of transit times and resilience are due to high variability of the temporal distribution of precipitation.

## Conclusion

- Assessment method of the influence of **energy crops** on the water cycle is established.
- Multiple years of site **water balances** are gained without an expensive and maintenance intensive measurement system.
- Data can be used for **bioenergy land use planning** and **water protection**.
- **True pressure** on a system is always a combination of theoretical resilience and true input (e.g. fertilization, soil compaction).

funded by

Baden-Württemberg
MINISTERIUM FÜR WISSENSCHAFT, FORSCHUNG UND KUNST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